EMPACT Final Report

Submitted by

City of Somerville, Massachusetts

To

United States Environmental Protection Agency

Final Progress Report Summary

Period Covered by the Report: October 4, 2001 through December 31, 2003

Date of Report: March 31, 2004

EPA Agreement Number: R82933801

Title: Real-Time Water Quality Monitoring and Modeling for Equitable Recreation on the Mystic River

Investigators: PI: Vithal V. Deshpande, vdeshpande@ci.somerville.ma.us

Co-PI: Prof. Paul Kirshen, Prof. John Durant, Prof. Lee Minardi, Prof. Steve Chapra, Prof. Laurie Baise, Ms. Lisa Brucklicchio, Ms. Grace Perez (only for first year. She left the area and was replaced by Nancy Hammett with EPA permission.)

Institutions: City of Somerville, Massachusetts

Tufts University, Massachusetts

Mystic River Watershed Association, Massachusetts

Research Category: Environmental **M**onitoring for **P**ublic **A**ccess and **C**ommunity **T**racking (EMPACT)

EPA Project Officer: Madalene Stevens

Project Period: October 04, 2001 through December 31, 2003

Objective(s) of the Research Project

The project objectives are:

To collect data on water quality indicators—fecal coliform, enterococcus, DO, turbidity—along with data on depth, temperature, pH, conductivity and meteorological conditions in real-time to develop an "early warning" water quality forecasting model.

To present real-time and timely water quality data and information to the public using the Internet, color-coded flags, a variety of other printed and visual materials in several languages, and regular advisories in local print and broadcast media. The presentations will interpret the data into indices useful for everyday decisions about contact with the water.

Make recreational users and watershed residents aware of the real-time and timely data, indices and model available through this project. The focus is on reaching a large segment of the public, including those without easy access to the internet, to stimulate interest in finding and using the information from the project.

Inform watershed residents about the connections between human behavior and water quality through educational efforts that emphasize the value of this information for personal decisions and community health.

Progress Summary/Accomplishments

Over the entire project duration following milestones were acomlished:

1. Equipment installation – First year of the project
2. Experimentation planning – First year of the project
3. Biological and Physical parameters data collection at five locations across the lower Mystic river basin and Alewife brook – Two consecutive years during late spring, summer, early fall.
4. Website design, real time data collection on the web – Two consecutive years during data collection period referred in point #3 above.
5. Planning and initial development for predictive model based on logistic regression and multiple linear regression and statistical time series modeling. – First year of the project
6. Developed two sets of predictive models – Second year of the project.
7. Public participation and input in developing the website design – First year of the project.
8. Public meetings and participations for discussing and incorporating suggestion regarding the about pages of the project and for modeling issues.

All above-mentioned milestones are much required to pursue the State goal to make the river swimmable and fishable by year 2010. The data collection and analysis is helping to locate where biological parameters are affecting the stream. It is also helping to understand the impact of human activities on this vital natural resource in the region.

Publications/Presentations

Somerville's EMPACT project announcement was made in local newspaper *Somerville Journal* and National newspaper *Boston Globe*. There was a formal launch of the program which was attended by Congressman Michael Capuano, Mayor of Somerville Dorothy A. Kelly Gay, Tufts University President Lawrence Bacow, EPA Region 1 Administrator Robert W. Varney, and several professors from Tufts, City of Somerville and EPA Region 1 officials, Massachusetts Department of Environmental Protection (DEP) officials, Mystic River Watershed Association members and common public. There were several articles in Mystic River Watershed Association's newsletters on the different aspects of the project. City of Somerville publicized the news on the environmental portion of the City's website and Tufts University website.

Two formal presentations were made pertaining to public participation and education. One such presentation was made at Environmental Educator's conference in Boston while second was made at Massachusetts Executive Office of Environmental Affairs (EOEA) watershed initiative-Boston Harbor/Mystic Basin team meeting. Two research assistants made presentations of their work on EMPACT at Graduate Student Fair at Tufts University.

Future Activities

Although funding for this project was over in December 31, 2003, there will be additional data collection in the summer 2004. This data collection and the subsequent implementation of predictive model on the web will help to further understand health of the river and will also assist as outreach tool for public education about the watershed.

Supplemental Keywords

Real time data monitoring, public education, environmental education, Public Awareness, Natural resources, predictive modeling for river quality

Relevant Web Sites:

Somerville EMPACT site is located officially at www.mysticriveronline.org.

Final Progress Report

Brief Description

City of Somerville, Massachusetts (Somerville) received formal award from the USEPA for EMPACT project on October 4, 2001. The project is titled as *real-time water quality monitoring and modeling for equitable recreation on the Mystic River.* As the name suggests the aim of the project is to deliver real time predictive model for Bacterial and Physical data in Mystic River at the points of recreation. This project is limited to the area of "Lower Mystic Basin" and Alewife brook, which is surrounding Somerville and neighboring towns, near Boston Harbor.

Over the two and half years period this project achieved all anticipated tasks for the project, which include: Equipment installation, data collection, data analysis, predictive model development, interactive website development, public participation and outreach. The predictive model, however, was not used on the web site during the project period as it was under development and peer review process. It is expected to be part of summer 2004 activities that the predictive model will be examined by actual collected data.

In addition to the completed tasks and deliverables, this project attracted neighboring Everett city's citizen who secured funds through EPA NE Region from supplemental environmental project (SEP) to install one monitoring station for data collection. Project website also received attention from City of Sioux Falls, SD who requested the advisory assistance in their similar website development.

Data Collection

Based on project boundaries, total of five monitoring stations were installed. Three stations are located in Somerville while remaining two stations are located in neighboring cities Arlington and Winchester. The locations are as shown in Figure 1, EMPACT Station Locations on Mystic River.

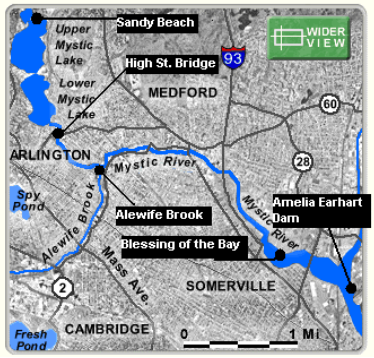

Figure 1: EMPACT Monitoring Stations on Mystic River

All stations are equipped for physical data monitoring, which include: temperature, pH, specific conductivity, dissolved Oxygen, and turbidity at specific depth at each station. All stations are connected via wireless medium, to Tufts University server. During the months of recreation starting May through October, every fifteen minutes data were collected and for May through October of 2002 and 2003. Although the project is over, it is expected to have data collection during summer of 2004 too.

Daily sampling was performed at all same stations as well as upper Mystic location near Aberjona River at USGS gate station for bacterial monitoring. For all six locations Fecal Coliform and Enterococcus Coliform data was collected during storm events.

All sampling and analysis has been performed with strict standards of Quality Assurance Project Plan and Sampling Standard Operating Procedures submitted to EPA at the beginning of the project.

Due to severe vandalizing of equipment at initial location on Alewife Brook, it was required to change the location to safer place. Also while making this change additional time required due to permitting procedure required to follow state regulations, such as approval by Somerville's Conservation Commission. The similar permit was also required from Winchester Conservation Commission for Sandy Beach station.

COMPUTER MODELING

Model Description.

A major goal of the project was to develop a predictive enterococcus bacteria model for the major recreation sites of Sandy Beach and Blessing of the Bay Boathouse. Two types of statistical model were developed. A logistic regression model which gives the probability of exceeding the swimming and boating standard was developed as part of the MS thesis of Oriel (2003). An ordinary least squares model, which predicted bacteria concentration was developed as part of the MS thesis of Heberger (2003). Both used as independent variables days since the last rainfall and the total of the precipitation over the last 24 hours at the Aberjona gage. Heberger's model was then extended to estimate the probability of exceeding the safe standard using the distribution of the estimated bacteria value and the cumulative distribution theory. It was decided that the recreating public would want both the estimated value as well as the probability of exceedance: therefore Heberger's model was applied to both locations.

Performance Criteria

The analysis of the selection of the exceedance probability that should be used to decide to *not allow recreational activities* as the sites from the Heberger (2003) analysis was that when the logistic regression model predicted a probability of exceedance of the standard of 20 percent or greater, the area should be closed. The value for the ordinary least squares model was 30 percent. The project stakeholder advisory committee after review of this recommended the exceedance level be set at 50 percent, the value used in the neighboring Charles River basin with a similar logistic regression model. Therefore, this higher level will be used and compared to actual sampling data and then the value adjusted if necessary.

Peer Review

The theses and memo have been reviewed by several faculty member at Tufts - both members and nonmembers of the thesis committees. The major conclusion is that bacteria is extremely

difficult to model (see Table 1 in Oriel, 2003) and that our models are generally the same or better than other models in other locations in terms of prediction accuracy. In fact, given the uncertainty in measuring bacteria in a river, it may not be possible to significantly improve model accuracy.

All test results, model theory, mathematics, uncertainty analysis, and overall documentation will be submitted to the EPA on a comprehensive CD that will contain all theses, datasets, website view etc.

WEB DEVELOPMENT

Basic web development was completed on the Tufts University server in the first year of the project. During second year it was made public after it was rerouted through the City of Somerville server and the unique Internet address www.mysticriveronline.org. Most of the basic website is available in bilingual format – English and Spanish. However about pages for Spanish version are not completely done in time due to limited resources for technical review of the content in Spanish language.

PUBLIC OUTREACH

Additional meetings have supplemented monthly meetings of the full EMPACT committee with the new MyRWA Executive Director, Nancy Hammett. It should be noted that in late November 2002, Grace Perez (the former MyRWA director, announced her upcoming move to New Mexico as of January 2003, so the work on the EMPACT project was minimized for those next two months. Nancy Hammett assumed the MyRWA leadership role and was heavily involved in this year's activities.

Accomplishments

Outreach efforts over the past year were largely focused during the recreational water use season from March through September. (Please refer to EMPACT Outreach efforts Spring-Summer 2003.) Efforts were made to engage a broader outreach and to provide public education opportunities in public venues. In addition to stated events, there were a number of meetings with representatives of Somerville service organizations that serve populations that are potential recreational users.

April was primarily utilized for public and media outreach through newsletter articles, list serves, and website links. An educational visit to a Somerville high school after school bilingual science club promoted the project and almost resulted in a summer student program utilizing the parameters of the EMPACT project though testing with Vernier probes in contrast to the EMPACT equipment, but testing at one or two of the same sites. The plans for the summer program fell through due to the changes in school personnel following the elimination of bilingual programming and the loss of the teacher as a result of budget cuts. However, two Tufts students have been set up working with the Somerville Science department to work with students on science fair projects, encouraging Mystic water quality related topics and working to integrate usage of the Vernier probes into science classes and to potentially redevelop plans for a concentrated school-based water quality program to tandem the EMPACT efforts.

May saw the formal announcement of the project's progress at the annual Mystic Herring Run and River Celebration event, on May 3rd, where Tufts and Somerville personnel staffed an information table in addition to formal reporting. Outreach for this event made a concerted effort

to reach boaters and families, with activities for each to complement the educational efforts. The local Boys and Girls Club, the local rowing teams, and local churches were involved actively, bringing new people in contact with EMPACT information. On May 17th, as part of the Mystic Super Cleanup, and information session was held at the Blessing of the Bay boathouse. This session was videotaped and became the centerpiece of a local cable show highlighting the EMPACT project on Channel 16, which was aired repeatedly since the summer.

A well-attended lecture evening in June attracted a number of new members of the community, being held in the Mystic Recreation Center at Mystic Housing Development. Tufts graduate student Matt Herberger presented a power point display, with physical exhibits of equipment and talked of his findings to that date.

In July, the brochure for EMPACT was unveiled at the Somerville ArtBeat community fair where a table drew large numbers of interested public. Likewise, the annual Fingerling Fling, an evening canoe trip in August, served as a popular forum for educating the boating public about the efforts of EMPACT. Similarly, the "Take Me to the River Festival" in Everett in early September reached many more local residents.

Some of the exhibits created and utilized for these outreach events include: laminated 11"x17" screen shots of the web pages, a CD that could replicate the web page on a laptop without internet access, a power point presentation, the EMPACT brochure, a MyRWA newsletter lead page article, two display boards created by Tufts graduate students on the water quality data and the data collection process, informational handouts, and press kits.

The Advisory Board was expanded as hoped to include a broader mix of members including EPA, local conservation commissions, public health agencies, boating representatives, and new MWC community partners. The members were not all able to attend every meeting, but have been able to provide representative input to the on-going process of public outreach and education. The board met approximately quarterly, with input sought and provided through electronic communication on an as needed basis, particularly with the development of the "About Pages". New members and old have been enthusiastically engaged in determining optimal outreach and education measures, often helping to host events. They are also determined to stay connected and some have developed potential funding sources to continue and/or advance the project, for example through adding an Everett monitoring site.

Challenges

Elements of public outreach that are still under development include the flagging program and the Boston Globe weather page notice. As the development and selection of the final model to be utilized for informing the public was delayed beyond the estimated time frame, it was impossible to create these elements in the temporal parameters of the grant. These two processes are well researched, with contacts in place for implementation where possible in the spring of 2004. Due to a change in structure at the state level regarding regional parks, there is still work to be completed to coordinate public notice of water quality from the EMPACT on-going project with the local swimming beach at Sandy Beach. The staff at Blessing of the Bay have identified that they need to upgrade their computer at their facility in order to facilitate participation in the flagging program. We have been reassured that this is not a deterrent, but "a detail" and we are seeking sources of a donated computer for this use.

The final version of the website is undergoing shifts based on recent input from the Advisory Committee but has largely been developed with significant input and revision based on community feedback, including the presentation of the modeling outcomes which will be viewed in Spring 2004. Additional public outreach and education are targeted by both MyRWA and the Mystic Watershed Collaborative as imperative to accompany the launch of the modeling predictions for water quality next spring and are the focus of fundraising for further support.

Future plans

The following list includes public outreach and education efforts planned for the future:

1. **Incorporate model predictions into website and design advisories**
    - Determine level to post red flags- plan to follow Charles River Watershed Association's model of using 50% or greater probability of exceeding boating standard as cut off point.
2. **Coordinate advisories with Massachusetts Department of Conservation and Recreation at Upper Mystic Lake**
3. **Institute flagging at boating locations:**
    - Blessing of the Bay.
    - Sandy Beach, in collaboration with Department of Conservation Resources
    - Potentially signage at others sites such as boat clubs or Little Mystic Channel.
4. **Institute notification to media outlets:**
    - Local access cable TV
    - Boston Globe weather page.
5. **Outreach to local community groups:**
    - Presentations on safe recreation at meetings of local groups
    - Revise brochure and distribute – town halls, health clinics, recreation departments, stores
    - Press conference, table displays at key cleanup events and festivals.

The Advisory Committee has expressed commitment to assist with the implementation of the above plans. The level of outreach and education will be partially determined by future funding, as there some of these involve expenditures beyond regular operating expenses for the City, Tufts, and MyRWA. The current economic climate also impacts the ability to fundraise, so the strategy of partnering with existing organizations and events will continue to be on one the most effective and efficient outreach and education approaches to continue to educate the Mystic residents about making informed decisions about recreational water-based activities.